AGRO 2015 MONTPELLIER
07 -10 SEPTEMBER

The International Scientific Week
on Agricultural Systems

FSD5
Proceedings

FSD Agricultural systems by design

SEPTEMBER
7-10, 2015
Le Corum
MONTPELLIER
France

5th International Symposium for Farming Systems Design

"Multi-functional **farming systems** in a **changing world**"

ESA European Society for Agronomy

AGROPOLIS INTERNATIONAL

Proceedings of the 5th International Symposium for Farming Systems Design

FSD5

Montpellier, September 7 - 10, 2015

Editors: Gritti Emmanuel S. – Wery Jacques
Cover design: Olivier Piau – Lisbeth Michel
Final edition: Gritti Emmanuel S.

Special thanks to the scientific committee's members for their commitment in the reviewing and editing processes

Pesticides pressure assessment using TFI (treatment frequency index) at the field, farm and watershed scale

Magalie Lesueur Jannoyer *±1, PhilippeCattan [2], Marie Raimbault [1], Céline Gentil [2], Vincent Bonnal [3] & Marianne Le Bail [4]

[1] CIRAD, Research Unit HortSys, CAEC, Petit Morne, BP 214, 97285 Le Lamentin, Martinique
[2] CIRAD, Research Unit GECO (Ecological functionning and sustainable management of Banana and Pineapple systems), Station de Neufchâteau, Sainte Marie, 97130 Capesterre Belle Eau, Guadeloupe
[3] CIRAD, UMR Tétis, Station de Neufchâteau, Sainte Marie, 97130 Capesterre Belle Eau, Guadeloupe
[4] AgroParisTech, SIAFEE Departement (Sciences et Ingénierie Agronomiques, Forestières, de l'Eau et de l'Environnement), UMR SADAPT, 16 rue Claude Bernard, 75231 Paris Cedex 05, France

* Speaker

± Corresponding author: jannoyer@cirad.fr

1 Introduction

In the French West Indies, pesticides highly impacts water bodies' quality (ODE Martinique, 2014). This is mainly due to farm practices associated with the high pest and disease pressure on crops, and also to the accelerated geochemical cycles increasing pesticide transfer (Mottes, 2013).
'Ecophyto 2018' Plan clearly targeted a reduction in pesticide use in all agricultural systems as a key option to reduce the contamination of the environment. The pesticide use reduction is monitored with a set of indicators, among them the treatment frequency index (TFI).
Little information is available on the phyto-sanitary practices according to cropping and farming systems in tropical areas. Our aim was to identify and assess the pressures sources at different space and time scales.

2 Materials and Methods

According to a farm typology, we surveyed 25 farms in Martinique and 23 farms in Guadeloupe, at two watersheds scale, accounting for contrasted agrosystems in terms of global farm strategy, of crop rotations and crop durations, of targeted markets (vegetables for farm consumption, sugarcane for transformation, export banana plantation…). To account for pesticide pressure for these agrosystems, we adapted the Treatment Frequency Index (TFI) (Brunet *et al.*, 2008) initially build for annual crops to infra or supra annual crops. We defined cropping units with homogeneous crop production management (vegetable cropping systems; planting year, medium production year, fallow year in banana production…) to assess different level of TFI (equation 1).

$$TFI_{field\,_i,cropj} = \sum_{t=1}^{t=T} \frac{Dt}{DAt} \times \frac{St}{Sfield\,_i} \qquad \text{(equation 1)}$$

with T:total number of pesticide treatments (in one or more category of pesticides); Dt: applied rate in active substances; DAt: approved rate for the active substances; St/Sfield$_i$ part of the field$_i$ with the treatment t; normalized on an annual basis.
For a multi-year crop with different type of management as the banana cropping system, we summed up the TFI for each homogeneous crop units (plantation, production and fallow periods) proportionally to their duration in the cropping system.
For a given farm, we summed up the TFI proportionally to the weight of each cropping system in the farm.
Spatializing these indices led to identify the contributive areas or cropping systems to pesticide pressure in both watersheds.

3 Results – Discussion

TFI values varied from 0 to 27 for one year between fields knowing that almost all practices complied with the regulation. Banana cropping systems had the highest TFI while sugarcane cropping systems had the lowest, because only herbicides are used. Horticultural and diversified cropping systems had intermediate TFI values. However, if farming systems including a high proportion of banana had the highest TFI they still showed a large variability of this index (Fig.1b). For part of them, animal or mechanical weeding was used instead of chemical mowing and the use field sanitation practices (use of *in vitro* plantlets after a fallow period) could explain the decrease of nematicides.
The TFI variability was also high considering the different phases of a crop cycle (Fig. 1a). For banana cropping systems, fungicides accounted for more than 80% of the TFI during the productive period, while herbicides accounted for the major part of TFI during fallow period. The plantation period differed with the productive period mainly because of a lowest TFI$_{insecticide}$. The variability depended on the duration of the productive period and fallow (Fig. 1b)

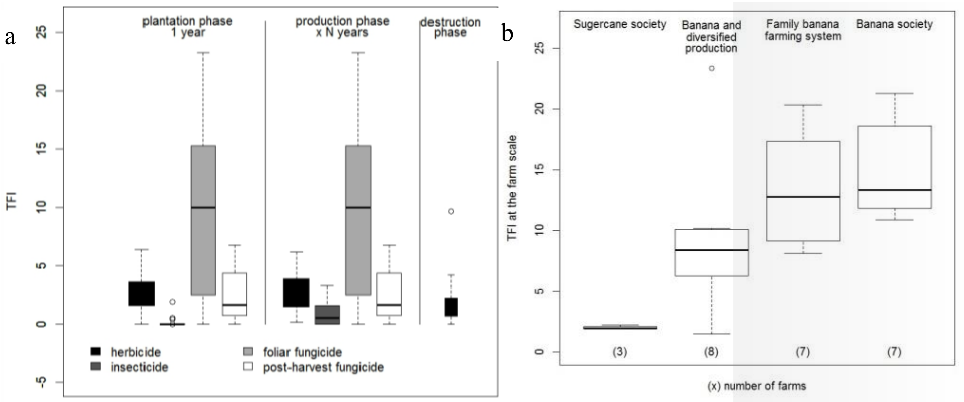

Fig. 1. TFIaccording to a. the cycle period for banana crop;
b. the farm system; Perou river Guadeloupe

At the watershed scale, the TFI spatialization according to pesticide use accounts for a diffuse high pressure of all systems for herbicides (Fig. 2a), compared to the local pressure of insecticides (Fig. 2b) and for a focused pressure of agro industrial systems for fungicides (Fig.2c). The contribution to the pesticides pressure of each system varied also according to the applied molecule: glyphosate pressure is the highest.

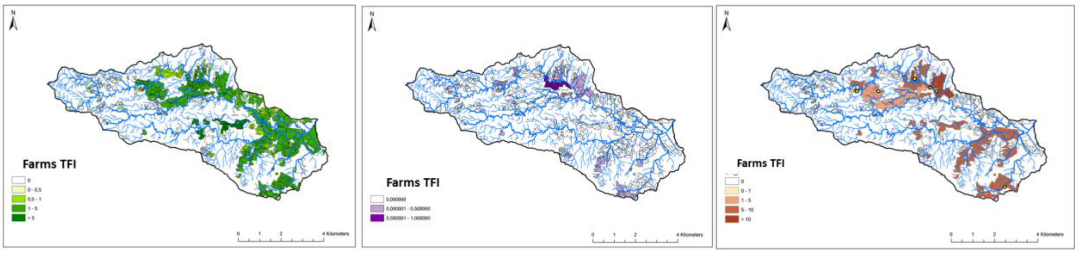

Fig. 2. TFIs at the Galion river (Martinique) watershed scale according to the pesticide target
a. herbicides (green) b. insecticides (purple) c. fungicides (red)

However, TFI is not enough to account for pesticide pressure and risk of river contamination (Bockstaller *et al.*, 2008). First, when the applied quantities (kg of active matter) are considered at the watershed scale, herbicides are the major contributor to the pesticide pressure and are frequently found in surface water. Second when TFIs are related with the pesticides residues measured in the river, post-harvest fungicides are more frequently detected in water while foliar fungicides accounted for the highest TFI. Thus the inflow source is of importance: a concentrated source had a major effect than a diffuse field source. Finally, TFIs do not account for the molecule characteristics, i.e. the hypothetic pesticide transfer route through water bodies, and thus it is not possible to clearly link pressure with impact for water quality.

4 Conclusions

The pesticide pressure assessment using TFIs, is part of the agrosystem diagnosis in the in order to improve pesticide management at the territory scale. Our results will help us to identify the major efforts of pesticide use reduction to focus on (herbicides and fungicides), the major contributors to the pesticide pressure and the ability of certain farming systems to reduce their pesticides. Those results will open to define a monitoring system for water resources quality, using additional information such as applied pesticides quantities, molecular characteristics and application modes.

Acknowledgements. We are very grateful to the UE FEDER funds, the ONEMA funds and the Cirad funds that have supported this project.

References

Bockstaller C., Guichard L., Makowski D., Aveline A., Girardin P., Plantureux S. (2008) Agri-environmental indicators to assess cropping and farming systems. A review. *AgronSustainDev* **28**:139–149.

Brunet, N., Guichard, L., Omon, B., Pingault, N., Pleyber, E. & Seiler, A. (2008) L'indicateur de fréquence de traitements (IFT): un indicateur pour une utilisation durable des pesticides. *Courrier de l'environnement de l'INRA*, **56,** 131-141.

French Ministry of Agriculture and Fishery (2008) Ecophyto2018 Plan, Paris.

Mottes, C. (2013) Evaluation des effets des systèmes de culture sur l'exposition auxpesticides des eaux à l'exutoire d'un bassin versant.Proposition d'une méthodologie d'analyse appliquée au cas de l'horticulture en Martinique. AgroParisTech, Paris.

ODE, French Water Observatory of Martinique (2013) Valorisation des données de suivi dela qualité chimique de l'eau DCE. Année 2011. Fort de France.